Art. XIX.—*The Anatomy of Two Australian Land Snails, Paryphanta atramentaria, Shuttleworth, and P. compacta, Cox and Hedley.*

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(With Plates XV.-XVII.).

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Among some snails (kindly sent to me by Mr. F. J. Thomas, to whom my thanks are due) from Beech Forest, Victoria, were some specimens of *Paryphanta compacta*. Figures, and a description, of the shell of this new species of *Paryphanta* have been given by Dr. Cox and Mr. C. Hedley in their "Index to the Land Shells of Victoria,"[1] but no account has hitherto been given of the animal itself.

The specimens of *P. atramentaria*, which were used in this work, were collected by myself about three years ago, at Blacks' Spur, near Healesville, Victoria. I did not use the animals at the time, and had only this preserved material for working this species. Several descriptions of the shell have been given, but so far as I know, the anatomy has been scarcely touched. I have been unable to see Shuttleworth's original description in Mittheil. Naturf. Gesell., Bern, 1852.

External Features and General Description.

P. compacta.

Dr. Cox and Mr. Hedley describe the colour of the shell as "brown, deepening on the last whorl to black, and on the second whorl passing into straw yellow." The animal itself is dark grey, with a lighter grey round the mouth and the side of the foot, becoming almost white down the mid line of the sole of the foot.

I took measurements of preserved specimens to compare with *P. atramentaria*. An average specimen measured:—

Shell, maj. diam. 20 mm., min. diam. 16 mm., height 15 mm.; sole of foot 20 mm. long, 10 mm. broad; height of part outside shell, 8 mm.

1 Mem. Nat. Mus. Melbourne, No. 4, 1912, p. 8, pl. i., figs. 3, 4, 5.

There is only one feature in the external description of this animal which I deem worthy of special comment. On examining the live animal, at first sight the smaller tentacle of each side appears bifurcated or double, but on closer examination, the lower of the two parts is seen to be depressed inwards at the tip, instead of ending in a little swollen knob, as the upper does. This depression, I think, is really the opening of a little gland, and I am told that when the animal is crawling, mucus can be seen exuding from this opening, but I have not observed this myself. Mr. Suter, in his communications from New Zealand, in the Journal of Malacology, 1899, Vol. VIII., Pl. III., has drawn a figure of *Rhytida greenwoodi*, in which the "buccal papillae," as he names them, resemble the structures in *P. compacta* more than any other I have seen.

P. atramentaria.

The animal is much larger than *P. compacta*. The shell is flatter and of about the same colour, or, perhaps, a little lighter. The animal itself is the same dark grey colour except at the edge of the mantle and the foot, where it is coloured a brilliant orange-red.

I took the following measurements from an average specimen :— Shell, maj. diam. 31 mm., min. diam. 26 mm.; height, 18 mm.; sole of foot, 35 mm. long, 17 mm. broad; height of part outside shell, 12 mm.

I have not observed the tentacle in the living animal, but I have one preserved specimen (Plate XV., Fig. II.), in which the two pairs of tentacles are withdrawn, but on each side is a little papilla on the under surface of which is a groove. The left inferior tentacle and papilla of this specimen, was cut out and used for sections.

In other carnivorous land Pulmonates, e.g., *Rhytida*, structures spoken of as labial palps are developed; but these in *Paryphanta*, more especially in *P. compacta*, seem to me to be more nearly connected with the tentacles than with the mouth.

In their internal structure, the two species resemble one another very closely, so that the one description may serve for either, except when otherwise stated.

Organs of the Mantle Cavity.

The kidney is a large, roughly triangular, granular body, pinkish grey in colour, lying on the dorsal side of the last whorl, at the back of the roof of the mantle cavity.

The pericardium forms a pear-shaped sac, lying to the left of the kidney. Through it the auricle and ventricle can be seen.

The renopericardial canal, the ureter, and the rectum, occupy their usual positions, and present no points of special interest.

The Reproductive System.

The reproductive systems of the two species are very similar. In *P. atramentaria*, the hermaphrodite gland is, comparatively speaking, less compact, the hermaphrodite duct is shorter, the albumen gland is larger and coarser, and the receptaculum seminis is slightly smaller than in *P. compacta;* also the vas deferens, in *P. atramentaria*, runs a little further behind the anterior end of the penis, before turning to run to its posterior end. With these differences the following description applies to either species. The hermaphrodite gland has the form of a loose rosette, the lobes of the rosette being somewhat pear-shaped. It is embedded in the liver near the inner edge of the second last whorl of the visceral hump, the first whorl being that nearest the centre. From the hermaphrodite gland the hermaphrodite duct runs in a sinuous course to the albumen gland.

The albumen gland is large and compact; it is indefinitely marked off by slight constrictions into three large and one smaller lobe. It lies near the beginning of the rectum, between this and the first part of the intestine. The common duct is broad and about half as long again as the albumen gland. One side of it is transversely grooved, the other smooth. These two parts eventually separate to form the viaduct and vas deferens respectively.

Shortly after the division of the common duct into vas deferens and oviduct, a long diverticulum is given off from the dorsal surface of the oviduct; this ends in a little swollen knob, the receptaculum seminis. This diverticulum runs right back so that the receptaculum seminis is situated under the auricle.

The penis is a very muscular body, lying beneath the right superior tentacle and across the pharynx.

The retractor penis muscle is attached to its posterior end.

The vas deferens at first sight appears to open into the penis near its anterior end, but further dissection shows that it runs a little behind the anterior end of the penis, then turns and runs back to open into it near its posterior end, just near to where the retractor muscle is attached, at the swollen portion. Its course may be understood by reference to Plates XVI. and XVII., Figs. VI. and X. The oviduct opens to the exterior, just to the right of the penis, through the genital aperture.

The Alimentary System.

The mouth, situated on the under surface of the head, opens into a relatively huge buccal mass or pharynx, running almost the length of the foot. The walls of this pharynx are extremely mus-

cular, more especially so at the posterior end, where they form a rounded muscular pad. Two stout muscle bands are attached to the dorsal surface of the posterior end of the pharynx, and their other ends to the columellar muscle; these assist in the contraction of the pharynx. A number of protractor muscles are attached to the anterior end of the pharynx, and at their other ends to the walls of the anterior end of the body and head.

If the pharynx is opened from the side, the radula can be seen lying on a muscular band, which anteriorly becomes developed into a pad. Attached to this pad are special muscles, connected with the roof of the pharynx, which assist in the forward and backward movement of the radula. There is no jaw. The radula is large, as is usual in the carnivorous land mollusca. It consists of about 98 rows of approximately 118 strong, sickle-shaped teeth, each with a very sharp pointed end and a broadened base, the base being produced in a little knob on the inner side of the sickle, and in the outer teeth being almost quadrate in shape. There is no rachidian. The uncini are larger than the laterals, and of the uncini themselves, those towards the centre are not so large as those near the outside, but the two or three most external become smaller again; this last feature is more marked in *P. atramentaria* than in *P. compacta*. Where one would expect the rachidian, there is a clear space, and on either side of this are teeth much smaller than the laterals, and arranged irregularly; beyond these are the laterals, at first placed almost straight and later becoming more and more triangular till we come to the marginals. I measured the radulas of the two species. That of *P. compacta* was 18 x 4 mm., and *P. atramentaria* was 20 x 5 mm. The teeth are of the same general type in both species, the differences may be seen in Plate XVII., Figs. IX. A. and B. Mr. Suter has given the dental formula for *P. atramentaria* as 50.1.50. I could not find any rachidian, but down the centre of the radula is the clear space I have mentioned above, and to either side of this the irregularly arranged teeth, about one-third the size of the adjacent laterals. I also, in my specimen, counted at least 56 teeth on each side of the central space, but could not be sure of the exact number, as the radula was slightly torn at the margin.

The oesophagus leaves the pharynx from its dorsal surface, about one-third of its length from its anterior end. It runs as a straight, narrow tube for some distance, and then widens slightly to form the stomach. The canal then twists round, as the intestine, under the stomach, and continues running through the liver and finally twists back to run along the right edge of the pulmonary chamber, and opens to the exterior at the pulmonary opening.

The salivary glands are two pear-shaped bodies, lying one on either side of the alimentary canal, just at the beginning of the stomach; they unite in the midline dorsally; from each a duct runs forwards to open into the pharynx, just beside the oesophagus.

The liver forms most of the visceral mass. One of its ducts is seen in Plate XVII., Fig. VII.

The Nervous System.

The cerebrial ganglia are two oval bodies, lying on the dorsal surface of the anterior part of the oesophagus; they are connected in the centre so as to form a band across the alimentary canal. From them two connectives run round each side of the oesophagus to the sub-oesophageal ganglia. Large nerves are given off to the tentacles, both superior and inferior, and one large nerve to the little glandular structure near the inferior tentacle.

The sub-oesophageal ganglia consist of the pedal ganglia, from which nerves pass to the foot, and the visceropleural ganglia from which nerves pass to the viscera and the body-wall.

The eyes do not differ from the ordinary pulmonate type. They are situated a little to the back of the top of the tentacle. In Plate XV., Fig. I., this is not clearly shown, owing to the position of the head, but it may be better seen in Fig. III.

The inferior tentacle, as has been mentioned above, has a little glandular structure with an opening at its base. This structure seems different in the two species. In *P. compacta* it seems to form a little pit on the top of a papilla, while in *P. atramentaria* it has the form of a little papilla with a groove on its under surface; but I have not examined the structure in the living *P. atramentaria*. In sections the glands are composed of the same forms of cells, and in each species there is a large amount of dark staining material, probably mucus, present. In *P. compacta*, however, the gland is not nearly so definite, and seems to lie more in the cephalic wall than in *P. atramentaria*. This may be clearly seen on comparing Figs. IV. and V. in Plate XV. Woodward has noted the very prominent "labial tentacles" of *Nanina caffra*. He says they are extremely sensitive, and "probably tactile in function, but not used for prehesion as suggested for *Glandina*."

I can make no definite assertion as to the function of these structures; they are certainly glandular, and as they are present on carnivorous snails, I think they must have some use in either the capture or killing of their prey.

The pedal gland resembles those described by Mr. Collinge for *P. hochstetteri* and *P. edwardi*. It is greatly developed and folded

on itself, lying on the floor of the body cavity. In *P. compacta* it turns to the right, and then to the left; in *P. atramentaria* it only bends slightly to the left before dipping into the cavity bounded by the pedal muscles.

Dr. Cox and Mr. Hedley have placed the genus as follows:—

Group, Sigmurethra; sub-group, Agnathomorpha; family, Rhytididae; genus, Paryphanta.

P. compacta is a new species of Cox and Hedley, but *P. atramentaria* was formed by Shuttleworth in 1852. One or two species have been suggested, at different times, as being most nearly related to *P. atramentaria*. Godwin-Austen has suggested placing *P. atramentaria* and *P. splendidula* in another genus. Suter considers *P. edwardi* stands nearest *P. atramentaria*. Cox and Hedley consider *P. compacta* nearest *P. atramentaria*, and there is a very close resemblance; the differences have been noted in the above for the animal itself, and the following are the differences in the two shells as noticed by Dr. Cox and Mr. Hedley:—"The novelty is nearest in the genus to *P. atramentaria*, but with as many whorls in about half the diameter, the whorls increase more slowly, the last whorl is proportionately smaller, the perforation narrower, and the whole shell more globose. In size it resembles the Tasmanian *P. fumosa*, but the whorls of *compacta* are wound more nearly in the same plane and increase less rapidly. It seems confined to the southern part of the State, while *atramentaria* inhabits the centre."

Unfortunately, I have been unable to consult Bentler's paper, "Die Anatomie von P. hochstetteri, Pfr.," Zool. Jahrb. (Anat. und Ontog.) XIV., 1901, as the work was not procurable in either Melbourne or Sydney.

I wish to thank Dr. Hall, under whom this work was carried on, for all his advice and help; also Miss Raff, M.Sc., for her assistance in procuring specimens.

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EXPLANATION OF PLATES.

In all figures:—

A.	Anus.
A.G.	Albumen gland.
Aur.	Auricle.
B.C.	Buccal cavity.
B.M.	Buccal mass or pharynx.
B.V.	Blood vessel.
C.D.	Common duct.
C.G.	Cerebral ganglia.
E.	Eye.
F.	Foot.
Gl.	Glandular tissue.
G.P.	Glandular papilla.
H.D.	Hermaphrodite duct.
H.G.	Hermaphrodite gland.
I.	Intestine.
I.R.	Small irregular central tooth.
K.	Kidney.
L.	Liver.
L.D.	Liver duct.
L.T.	Lateral tooth.
M.	Mouth.
Mg.	Marginal tooth.
N.	Nerve.
O.	Oesophagus.
OD.	Oviduct.
P.	Penis.
P.O.	Pulmonary opening.

R.	Rectum.
Rad.	Radula.
R.M.	Retractor muscle.
R.O.	Reproductive opening.
R.S.	Receptaculum seminis.
S.	Stomach.
S.D.	Salivary duct.
S.G.	Salivary gland.
T.I.	Inferior tentacle.
T.S.	Superior tentacle.
V.	Ventricle.
V.D.	Vas deferens.
V.H.	Visceral hump.

Plate XV.

Fig. I.—*P. compacta;* the living animal; showing the glandular papilla below the inferior tentacle.

Fig. II.—*P. atramentaria;* head of preserved specimen; showing the retracted superior and inferior tentacles, and the little papilla with the groove on its under surface.

Fig. III.—*P. compacta;* head of living animal; showing position of eye, and the glandular papilla; to compare with Fig. II.

Fig. IV.—*P. compacta;* section of body wall and right inferior tentacle; showing glandular structure beneath the inferior tentacle.

Fig. V.—*P. atramentaria;* section of glandular papilla; showing structure; to compare with Fig. IV.

Plate XVI.

Fig. VI.—*P. compacta;* dissection to show the general arrangement of organs.

Plate XVII.

Fig. VII.—*P. compacta;* alimentary canal.

Fig. VIII.—*P. compacta;* pharynx cut open from the right side to show the radula *in situ*.

Fig. IX. A.—Types of teeth; *P. compacta*.
B.—Types of teeth; *P. atramentaria*.

Fig. X.—*P. compacta;* dissection to show the vas deferens and penis.